Space Weather Technical Forecast

Issued on Sunday 6 October 2024 at 13:29 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: G1/G2 expected Day 1 (06 Oct), reducing to a chance on Day 2 (07 Oct). Isolated R1/R2 expected on all days.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Moderate with a peak M2.4 flare observed from AR3842 at 05/2320 UTC and frequent mid-high level C-class flares from multiple regions during the period.

There are seven sunspot groups on the visible disc. AR3842, the second largest and most active flaring region, located in the southwest, maintained a strong leading delta spot, but saw decay in its intermediate and trailer spots. Similarly, AR3844 to the west underwent slow decay in its intermediate and trailing regions. The remaining regions appear broadly similar, though with some slight growth evident in AR3848. Located in the northeast, it is the largest sunspot on the facing disc, though the region has been largely stable and inactive in the past 24 hours.

There is a large filament in the south central disc that is currently proud of its underlying magnetic neutral line and has been for some time. Given its location this is something to monitor.

CME activity observed in coronagraphs was generally confined to high latitudes narrowly over the western solar horizon - to no effect at Earth. Therefore no new Earth-directed CMEs were in evidence.

Solar Wind / Geomagnetic Activity: The awaited X9.0 CME from 03 Oct arrived at L1 at 06/0655 UTC with a modest enhancement to solar wind parameters. The solar wind varied between Slightly Elevated and Normal Background speeds for much of the period, increasing to between Elevated and Slightly Elevated levels (peak 537km/s at 06/1028 UTC) following the CME arrival. Despite this, the solar wind density remained at Below Average levels throughout. The Interplanetary Magnetic Field (IMF) fluctuated largely around the Weak to Moderate threshold, but was enhanced to Moderate to Strong levels following passage of the CME front (peak 15nT at 06/0701 UTC). The north-south component varied Weakly for much of the period, but strengthened after the CME arrival to between +15/-7nT. The phi angle was largely negative (towards the Sun).

The net result of the above solar wind measures was Quiet throughout (Kp0-2).

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux observed by GOES18 was at Background levels.

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High energy electron flux (greater than 2MeV) observed by GOES16 was at Normal Background to the bottom end of Moderate levels (at diurnal peak). The associated 24-hour fluence was below the Active threshold, roughly level with 2.4e6 observed at 05/2359UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is Expected to be Moderate, with a slight chance of increasing to High levels given a risk for isolated X-class flares, mainly from AR3842 and AR3844. Recurrence does not suggest any returning large regions over the eastern solar horizon in the forecast period, however there should now be a slight depopulation of the southwestern quadrant by UTC midweek to slightly reduce the overall flare probabilities by this time.

Solar Wind / Geomagnetic Activity: Solar winds have increased to between Elevated and Slightly Elevated levels following the earlier arrival of the CME from the X9.0 flare of AR3842 on 03 Oct. Speeds should slowly decline in the coming days as CME effects subside. There is a chance of a glancing impact late on Day 2 (07 Oct) or early Day 3 (08 Oct) from a CME that left the southwest quadrant of the Sun on 04 Oct.

The only fast wind in the forecast is likely from a small equatorial coronal hole in the western disc, which may become geoeffective later on Day 2 or early Day 3 (07 or 08 Oct), but may be indistinguishable from the residual enhancements caused by the recent CME arrival. Speeds for the high speed stream are unlikely to exceed 500km/s.

Geomagnetic activity is expected to reach G1-G2/Minor to Moderate Storm levels on Day 1 (06 Oct), with a chance of peak G3/Strong intervals resulting from the recent CME arrival. Activity should then return to Unsettled to Active levels on Day 2 (07 Oct). Geomagnetic activity is forecast to be Quiet to Active on Days 3 and 4 (08 and 09 Oct), but there is a chance of further G1 activity resulting from minor coronal hole or CME enhancements on Day 3 (08 Oct).

Energetic Particles / Solar Radiation: High energy proton flux at GOES18 is forecast to persist at Background, with a daily chance of exceeding the S1/Minor Storm threshold should further significant flares occur.

High energy electron flux at GOES16 is expected to be at Background to Moderate levels through much of, if not the entire forecast period. There is a chance of daily High flux being reached as CME and coronal hole enhancements subside on Day 4 (09 Oct). 24-hour integrated fluence is expected to remain well below the Active (1e8 integrated flux) threshold. Any lasting recovery will probably not come until later in the coming UTC week.

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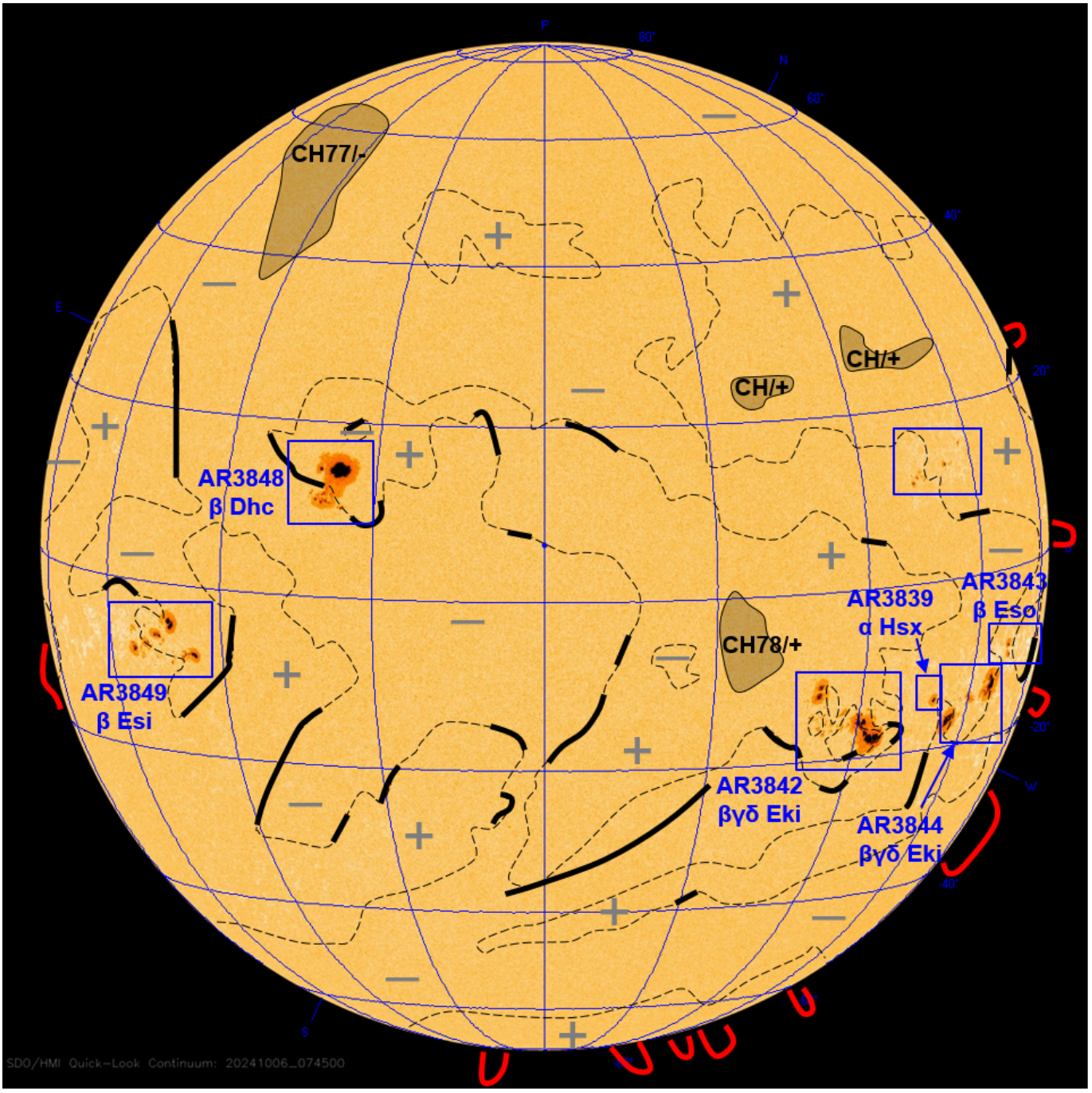
Figure 1: MOSWOC Solar Synoptic Map valid 06/0745 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms

A CME was detected at ACE at 06/0655 UTC, likely the delayed arrival of the CME resulting from the X9.0 flare of AR3842 on 03 Oct. So far the response in solar wind parameters has been fairly modest, but is likely to increase once Earth passes through the magnetic cloud of the CME.

One potential CME arrival features in the forecast period. The M4.0 flare of AR3842 on 04 Oct resulted in a CME evident in LASCO and STEREO A imagery, but appears to overlap with pre-existing ejecta from two filament eruptions in the southwest disc from a similar period, reducing confidence in the analysis of the feature. A glancing impact is possible according to MOSWOC Enlil later on Day 2 (07 Oct) or early Day 3 (08 Oct) but with the bulk of the ejecta expected to pass below and ahead of Earth.

Current wind speeds are between Elevated and Slightly Elevated levels (around 450-530km/s), with a slow decline expected during Days 1 and 2 (06 and 07 Oct) as the CME subsides at Earth. The only fast wind in the forecast is likely from small equatorial CH78/+, in the western disc, which may become geoeffective later on Day 2 or early Day 3 (07 or 08 Oct), but may be indistinguishable from the residual enhancements caused by the recent CME arrival on 06 Oct. Speeds for the high speed stream are unlikely to exceed 500km/s.

Geomagnetic activity is expected to reach G1-G2/Minor to Moderate Storm levels on Day 1 (06 Oct), with a chance of peak G3/Strong intervals resulting from the recent CME arrival. Activity should then return to Unsettled to Active levels on Day 2 (07 Oct). Geomagnetic activity is forecast to be Quiet to Active on Days 3 and 4 (08 and 09 Oct), but there is a chance of further G1 activity resulting from minor coronal hole or CME enhancements at first.

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	90	50	20	5
Strong	G3	No	30	5	1	1
Severe	G4	No	5	1	1	1
Extreme	G5	No	1	1	1	1

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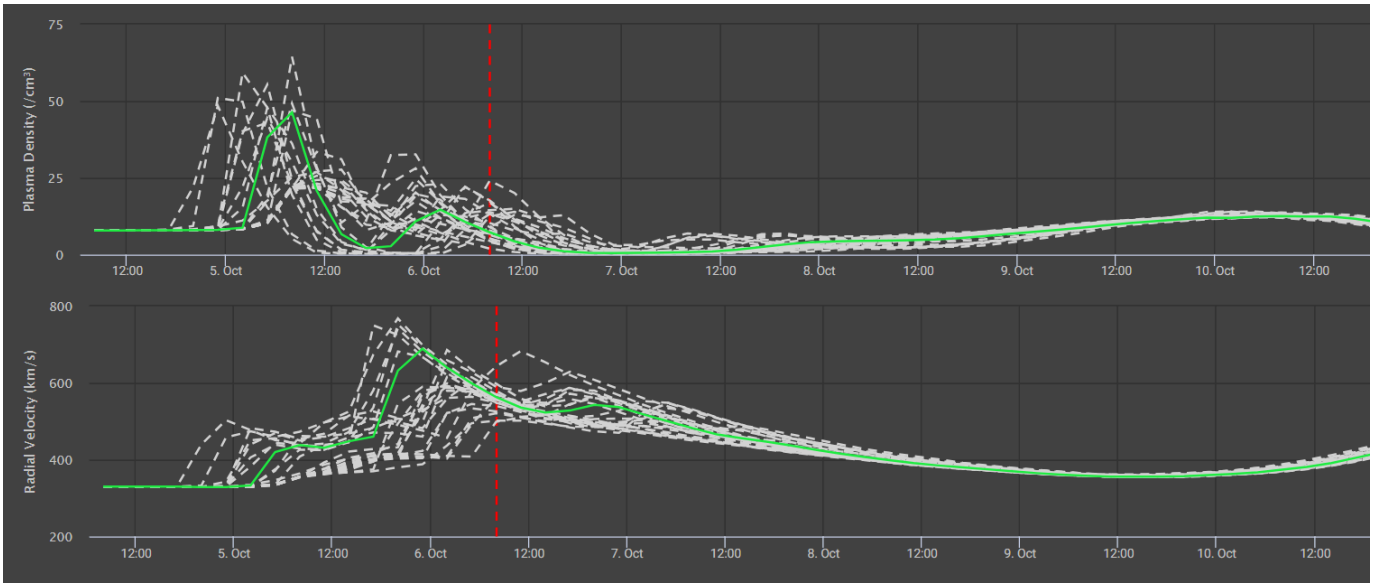
Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R⊙ (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed (km/s)	Estimated Arrival Time (UTC)	Comments
04/1040	Partial	AR3842 + Filaments	SW	585	07/1800 UTC	Moderate confidence in arrival. Low confidence in timings.

Figure 2: Latest MOSWOC Enlil Ensemble. A moderate number of Ensemble members indicating a glancing CME arrival late 07 or early 08 Oct from M4.0 flare of AR3842 and coincident filament eruptions.



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Radio Blackouts - X-Ray Flares

There are seven numbered sunspot groups on the Earth-facing disc. The southwest quadrant remains heavily populated with large, complex regions, namely AR3842 and AR3844. However, both have showed some recent decrease in overall size, with reduction particularly evident in the spots occupying their intermediate regions. Both harbour a very slight potential for X-class flares given their historical activity and continued presence of one or more delta spots. All other western hemisphere regions appeared to be in decay.

Meanwhile, in the eastern disc, AR3848 appears stable, but with a slight increase in size and retains a large symmetrical spot. Similarly AR3849 has also grown slightly, with an increase in the number of its minor spots, but is also largely inactive at this time.

Far side helioseismographs and returning Carringtons due in the period suggest that there are no significant inbound complex regions in the coming four days. The main consideration for X-ray flare risk is therefore any simplification (or intensification) of the current crop of active regions, as well as the gradual depopulation of the southwestern quadrant. AR3843 and AR3844 should rotate off in turn towards UTC midweek, and there is a resultant slight decrease in the probabilities of significant flares. Even with these departures, the risk of flares remains high due to the continuing presence of AR3842 and its large Mt Wilson delta spot.

Solar activity is Expected to be Moderate, with a slight chance of increasing to High levels given a risk for isolated X-class flares. The risk of Strong flares comes mainly from AR3842 and AR3844. AR3849 is perhaps also one to watch given recent growth.

X-Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 (M Class)	Yes	85	85	85	70
Very Active	R3-R5 (X Class)	No	15	15	15	10

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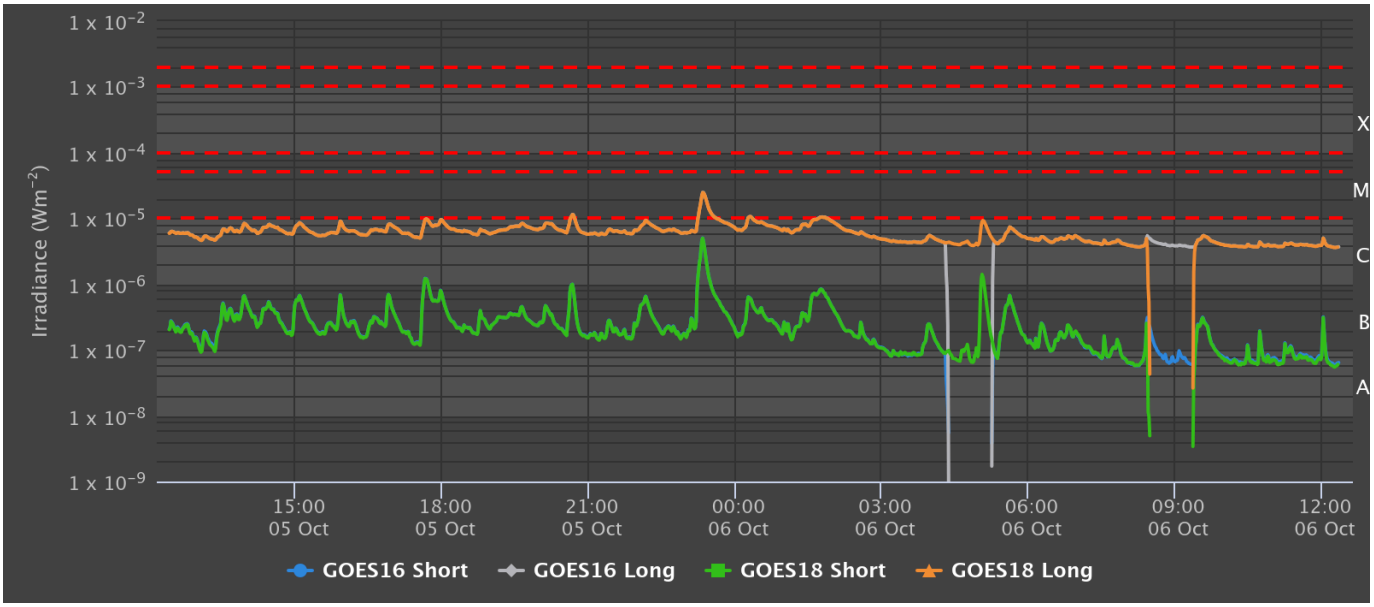
Figure 3: Latest GOES16/18 X-Ray Flux trace.



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Solar Radiation Storms (High Energy Protons)

High energy proton flux at GOES18 has thus far failed to respond to any of the recent large flares, however this becomes more likely with the sunspots' advance towards the western horizon. So, while modulated versus raw probabilities for the current disc, there remains a daily chance of S1+, mainly from AR3842 and AR3844. The risk of S1 may begin to moderate slightly as AR3843 and AR3844 rotate off the Earth-facing side towards UTC midweek.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	30	30	30	20
Very Active	**≥ S3 ***	No	5	5	5	5
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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High Energy Electrons (≥ 2MeV)

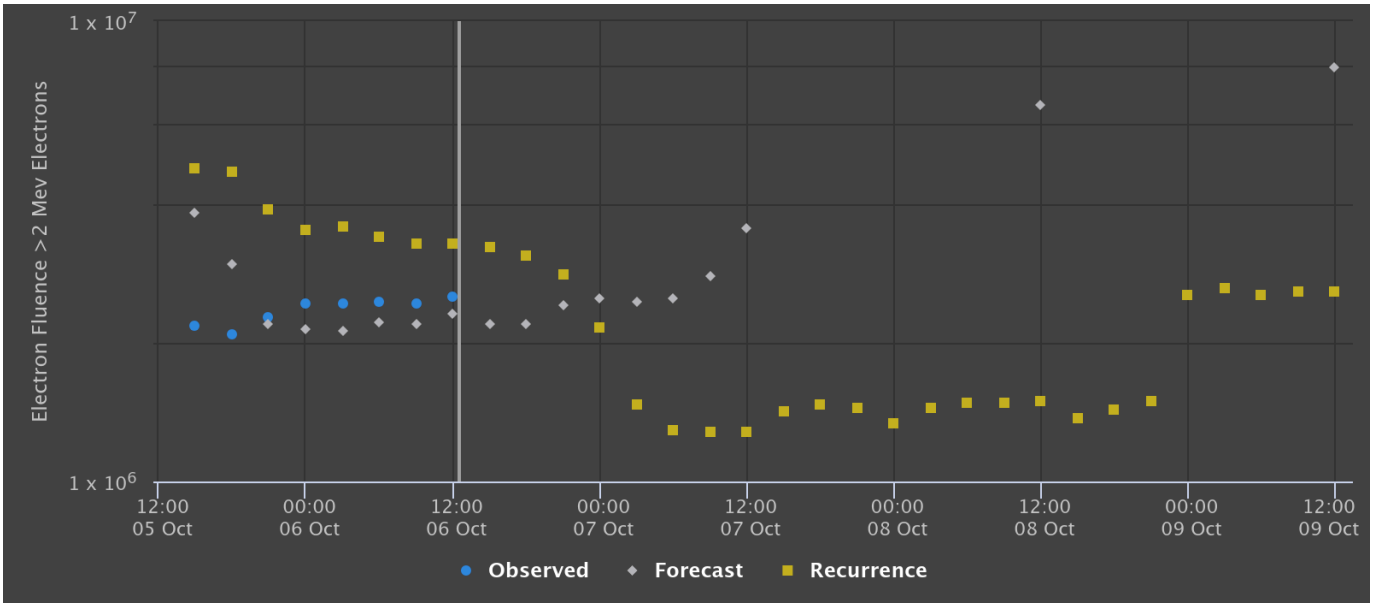
High energy electron flux (greater than 2MeV) observed by GOES16 was at Normal Background to Moderate levels. CME and coronal hole influence is likely to cause flux at GEO to remain subdued in the coming days, and the extent of any recovery on Day 4 (09 Oct) is also low confidence. Some periods of High flux are possible on Day 4 (09 Oct) as solar wind pressure eases, but more likely later in the coming week, outside of the current forecast period.

24-hour integrated fluence is expected to remain well below the Active (1e8 integrated flux) threshold. Any lasting recovery will probably not come until later in the coming UTC week.

MOSWOC REFM is not likely to offer a useful steer as to electron populations given the influence of CMEs in the forecast.

GEO Electron Environment	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ 1×10^{8}	No	1	1	1	5
Very Active	≥ 2 MeV ≥ 1×10^{9}	No	1	1	1	1

Figure 4: Latest MOSWOC REFM forecast with recurrence.



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